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| 10/810,066      | 03/25/2004  | Vishal Gauri         | NOVLP084/2872       | 3525             |

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| EXAMINER |
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SMOOT, STEPHEN W

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| ART UNIT | PAPER NUMBER |
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2813

DATE MAILED: 08/23/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

10/810,066

Applicant(s)

GAURI ET AL.

Examiner

Stephen W. Smoot

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 25 March 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-39 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 37-39 is/are allowed.
- 6) ☒ Claim(s) 1-12, 20, 23 and 26-30 is/are rejected.
- 7) ☒ Claim(s) 13-19, 21, 22, 24, 25 and 31-36 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 25 March 2004 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_.
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

## DETAILED ACTION

This Office action is in response to application papers filed on 25 March 2004 and to applicant's preliminary amendment filed on 29 June 2004.

### *Drawings*

1. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign mentioned in the description:

518 in Fig. 5 (see paragraph [0047], line 10).

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

2. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference character not mentioned in the description:

504 in Fig. 5.

Corrected drawing sheets in compliance with 37 CFR 1.121(d), or amendment to the specification to add the reference character in the description in compliance with 37 CFR 1.121(b) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

### ***Specification***

3. The disclosure is objected to because of the following informalities:

In paragraph [0041], line 1, change "Figure 21" to --Figure 2-- because there is no Figure 21 and it appears that Figure 2 is being referred to; and

In the Abstract, line 7, change "filing" to --filling-- to correct spelling.

Appropriate correction is required.

### ***Claim Objections***

4. Claims 33-36 are objected to because of the following informalities:
- In claim 33, step (a), line 1, after "substrate", insert --to-- to correct grammar;
- In claim 33, step (b), line 2, delete "at" to correct grammar; and
- Claims 34-36 are objected to because they depend on claim 33.
- Appropriate correction is required.

### ***Claim Rejections - 35 USC § 112***

5. The following is a quotation of the second paragraph of 35 U.S.C. 112:
- The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.
6. Claims 20, 28 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.
- Claim 20 recites the limitation "the field" in line 4. There is insufficient antecedent basis for this limitation in the claim.
- The term "reentrant features" in claim 28, line 1 is a relative term which renders the claim indefinite. The term is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the

art would not be reasonably apprised of the scope of the invention. It is not clear from the applicant's original disclosure what is meant by the term "reentrant features" with regards to the appearance or structure of the as-claimed gaps.

***Claim Rejections - 35 USC § 102***

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

8. Claims 1-3, 5, 7, 9-11, 27-29 are rejected under 35 U.S.C. 102(b) as being anticipated by Xia et al. (US 6,218,268 B1).

Referring to Figs. 6A-6C and column 12, line 33 to column 13, line 42, Xia et al. disclose a method for filling trenches having a width of 0.1 microns (i.e. 100 nm) or less that includes depositing BPSG using TEOS as a precursor, which implies a chemical vapor deposition process. The deposited BPSG can optionally undergo a reflow step to ensure that the trenches are completely filled with BPSG, which implies that the BPSG

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is liquefied (also see column 10, lines 35-43) during the reflow step and is subsequently solidified.

These are all of the limitations set forth in claims 1-3, 9-11, 27 of the applicant's invention. Regarding the Kelvin effect limitation, this is a property limitation that is presumed to be inherent to the disclosure of Xia et al., per MPEP section 2112.01, since their structure is substantially identical to the applicant's structure implied by the process as claimed in claim 1 (i.e. gaps having a dimension of about 100 nm or less containing liquefied precursor).

Regarding claims 5, 7, the trenches can be isolation trenches formed on a semiconductor substrate (also see column 1, lines 15-30).

Regarding claims 28-29, the trenches as shown in Figs. 6A-6C have vertical sidewalls and, as best understood by the examiner, a vertical sidewall is being interpreted to be a type of reentrant feature.

9. Claims 1-3, 5-6, 9-11, 27-29 are rejected under 35 U.S.C. 102(b) as being anticipated by Geiger et al. (US 2002/0006729 A1).

Referring to Figs. 1A-1C and paragraphs [0027] to [0038], Geiger et al. disclose a method for filling trenches having a width of 0.08 microns or 0.06 microns (i.e. 80 nm or 60 nm) that includes depositing BPSG by chemical vapor deposition (CVD) using TEOS as a precursor (also see paragraphs [0001] and [0002]). The deposited BPSG then undergoes a reflow step to ensure that voids are removed from the trenches, which implies that the BPSG is liquefied during the reflow step and is subsequently solidified.

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These are all of the limitations set forth in claims 1-3, 9-11, 27 of the applicant's invention. Regarding the Kelvin effect limitation, this is a property limitation that is presumed to be inherent to the disclosure of Geiger et al., per MPEP section 2112.01, since their structure is substantially identical to the applicant's structure implied by the process as claimed in claim 1 (i.e. gaps having a dimension of about 100 nm or less containing liquefied precursor).

Regarding claims 5-6, the trenches can be gaps formed between polysilicon gates on a semiconductor wafer (also see paragraphs [0001] to [0003]).

Regarding claims 28-29, the trenches as shown in Figs. 1A-1C have vertical sidewalls and, as best understood by the examiner, a vertical sidewall is being interpreted to be a type of reentrant feature.

10. Claims 1, 4-5, 8, 12, 23, 26, 28-30 are rejected under 35 U.S.C. 102(e) as being anticipated by Schneegans et al. (US 6,790,737 B2).

Referring to Figs. 3A-3D, 6A-6B and column 10, line 14 to column 11, line 50, Schneegans et al. disclose a method for filling openings in a silicon wafer having a diameter of about 100 nm that includes condensing tungsten hexacarbonyl to fill the openings with liquid tungsten hexacarbonyl. The condensed tungsten hexacarbonyl is subsequently thermally decomposed to form tungsten in the openings by heating the wafer. This process is repeated approximately 10 times in order to completely fill the openings with tungsten

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These are all of the limitations set forth in claims 1, 4-5, 12, 26, 30 of the applicant's invention. Regarding the Kelvin effect limitation, this is a property limitation that is presumed to be inherent to the disclosure of Schneegans et al., per MPEP section 2112.01, since their structure is substantially identical to the applicant's structure implied by the process as claimed in claim 1 (i.e. openings having a dimension of about 100 nm containing liquefied precursor).

Regarding claim 8 the openings can be contact opening (17) formed in a dielectric layer (15) as shown in Fig. 6A.

Regarding claim 23, the precursor can be applied in gaseous form or alternatively by spraying, dipping, or spinning (also see column 6, lines 1-28).

Regarding claims 28-29, the openings as shown in Figs. 3A-3D, 6A-6B have vertical sidewalls and, as best understood by the examiner, a vertical sidewall is being interpreted to be a type of reentrant feature.

### ***Allowable Subject Matter***

11. Claims 13-19, 21-22, 24-25, 31-32 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form to include all of the limitations of the base claim and any intervening claims.

12. Claims 33-36 would be allowable if rewritten or amended to overcome the objections set forth in this Office action.

13. Claims 37-39 are allowed.

14. The following is a statement of reasons for the indication of allowable subject matter:

- Claims 13-19 would be allowable because the prior art of record does not teach or suggest, in combination with the other claim limitations, a method of depositing a solid material on a substrate having gaps of dimension on the order of about 100 nm or less, that includes the step of selectively condensing a precursor of the solid material in narrow gaps from a vapor phase to a liquid, wherein the precursor is of a metal that includes a copper containing precursor (claim 13), an aluminum containing precursor (claims 14-17) or a tungsten metal halide (claims 18-19);
- Claims 21-22 would be allowable because the prior art of record does not teach or suggest, in combination with the other claim limitations, a method of depositing a solid material on a substrate having gaps of dimension on the order of about 100 nm or less, that includes the step of selectively condensing a precursor of the solid material in narrow gaps from a vapor phase to a liquid, wherein the substrate is contacted with the precursor in vapor phase at a partial pressure of at least about the saturation pressure of the precursor to form liquid in at least the gaps;

- Claim 25 would be allowable because the prior art of record does not teach or suggest, in combination with the other claim limitations, a method of depositing a solid material on a substrate having gaps of dimension on the order of about 100 nm or less, that includes the step of selectively condensing a precursor of the solid material in narrow gaps from a vapor phase to a liquid, wherein the liquid is converted to the solid material by reacting with another material;
- Claims 31-32 would be allowable because the prior art of record does not teach or suggest, in combination with the other claim limitations, a method of depositing a solid material on a substrate having gaps of dimension on the order of about 100 nm or less, that includes the step of selectively condensing a precursor of the solid material in narrow gaps from a vapor phase to a liquid, further combined with the step of depositing additional solid material in features that were not previously filled, wherein the substrate also includes gaps that are significantly greater than 100 nm; and
- Claims 24, 33-36 would be allowable and claims 37-39 are allowed because the prior art of record does not teach or suggest, in combination with the other claim limitations, a method of depositing a solid material on a substrate having gaps of dimension on the order of about 100 nm or less, that includes the step of forming a liquid corresponding to a vapor phase precursor in at least some gaps, wherein the liquid remains in the gaps when the vapor phase precursor is at a partial pressure that is below its saturation pressure.

### ***Conclusion***

15. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Ooka, Park, Dobson et al., Yabu et al., and Halliyal et al. teach gap filling methods that feature reflowing material. Galli et al. teach a method that features the liquid phase deposition of oxide material. Doan et al. teach a method that features decomposing a liquid to form solid silicon oxide.


16. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephen W. Smoot whose telephone number is 571-272-1698. The examiner can normally be reached on M-F (8:00 am to 4:30 pm).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8000.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

SWS

  
**STEPHEN W. SMOOT**  
**PRIMARY EXAMINER**